Notes on ....

Clutch hydration following oviposition by urination may reduce desiccation in thorny devil (*Moloch horridus*) eggs

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Abstract. During fieldwork in the eastern goldfields, a gravid female thorny devil (*Moloch horridus*) was collected. Whilst held in captivity the female deposited eight eggs in a calico bag and apparently urinated over the clutch. We propose that thorny devils may hydrate their eggs after oviposition to reduce desiccation during development in the nesting burrow. This may lead to a fitness increase for the offspring at hatching in the form of increased hatchling size

Key words: clutch, hydration, *Moloch horridus*, dragon lizard

Introduction

Among oviparous species, optimal nest site selection, nest construction and maintenance of the egg clutch (*e.g.* brooding) can contribute to a reduction in offspring mortality (Covacevich & Limpus 1972; Cooper-Preston 1992; Shine 1998) and increase offspring fitness (Shine 1988).

Desiccation of reptilian egg clutches occurs most rapidly in environments with low water vapour pressure and high thermal conductivity (Ackerman 1994), and in situations where a large proportion of the total surface area of the clutch is exposed to soil or open air (Ackerman & Dmi'el 1985). Consequently, reptiles often deposit their clutch in a burrow that provides thermal stability, higher humidity than ambient or surface conditions, and reduced exposure (Baudinette 1973; Bennett 1988; Roper 2001).

Like other agamids, thorny devils (*Moloch horridus*) lay eggs and excavate their own nesting burrow (Pianka *et al.* 1996; Thompson in press). Eggs are incubated in the burrow for approximately 115 days (range 90-132 days; Sporn 1965; Pianka *et al.* 1996), and during this time there is great potential for egg desiccation. We describe a fortuitous observation of clutch hydration that suggests thorny devils urinate on their egg mass as a mode of parental care to increase offspring fitness. Observations of this nature have previously been described for oviparous reptiles such as skinks (Fitch 1954; Somma & Fawcett 1989), crocodiles (Whitaker & Whitaker 1977) and snakes (Bell & Van den Sande 1986; York & Burghardt 1988; Ross & Marzec 1990; Shine 1998).

Observations

During fieldwork in the eastern goldfields of Western Australia (Koolyanobbing Ranges; 30° 29' S; 119° 30' E) a gravid female thorny devil was collected in open sand plain country. We placed the thorny devil in a calico bag (21 cm x 30 cm) and transferred it to our field station where it was held in a dark enclosure and maintained at temperatures between 18-22 °C. The lizard was monitored daily, and on the fourth day egg deposition had occurred in the calico bag. Eight eggs were deposited in total. In addition, we noticed that the calico bag was saturated with fluid and contained evidence of faeces (ant remnants). We concluded that the female thorny devil had urinated and defaecated over the clutch, resulting in saturation of the eggs and at least half of the calico bag.

Discussion

We suggest that this thorny devil, once confined but left undisturbed, had deposited its clutch and hydrated the eggs as it might do in a nesting burrow in the field. Egg deposition could have been a coincidental observation, or oviposition and defecation could have been a stress induced response to captivity. However, this is unlikely for two reasons. Firstly, reptilian excreta consists mainly of insoluble uric acid and undigested food material and contains very little fluid (Bradshaw 1997). A considerable amount of fluid must have been liberated from the cloaca to saturate the bag to the extent that we observed. Secondly, egg deposition was not likely to be a stress response as the normal response of gravid individuals to stress is egg retention (Hughes *et al.* 1986; Mills *et al.* 1991).

We therefore suggest that urination/defaecation was the action of an individual not unduly stressed by captivity and that clutch hydration in this fashion may be a tactic used by female thorny devils in the field to increase the number of eggs that hatch successfully and increase offspring size (Shine 1988; Shine & Brown in press). Thorny devils burrow in relatively compact substrates, such as red lateritic clays (Thompson in press), and these substrates should be favourable for incubation (*i.e.* humid with stable temperature). However, hydration of the clutch by the adult female during or after oviposition should substantially increase the relative humidity of the burrow and extend the period over which the burrow remains humid. Moreover, most reptilian eggs are permeable to water and potentially hygroscopic, drawing in water if the surrounding medium is sufficiently moist (Seymour *et al.* 1997; Quintana 2001). Urination over the clutch by the adult female may provide water for uptake and increase the total water content of the eggs, and increase offspring size at hatching.

Ackerman & Dmi'el (1985) reported that egg desiccation is accelerated by exposure to open air or dry soil. Thorny devils lay eggs in a chamber, leaving the eggs sitting on (rather than buried in) loose soil (Pianka

et al. 1996; Thompson in press). Such exposure, even in a burrow, would increase the likelihood of desiccation if burrow humidity were low. Manipulation of an egg clutch by the female after deposition has frequently been reported (see Shine 1988 for summary). Therefore it is not unreasonable to suggest that urination over the clutch may compensate for poor egg position and exposure to air that might otherwise increase egg desiccation.

Such a contribution toward an increase in offspring fitness comes at a cost to the adult. The potential cost paid by the female thorny devil following a contribution to clutch hydration is obviously its survival costs associated with increased water loss. However, these costs are likely to be low, as the thorny devil employs an extremely efficient hygroscopic technique for water acquisition (Bentley and Blumer 1962; Withers 1993), and is probably able to rehydrate relatively quickly after hydrating its clutch, provided water was available.

References

Ackerman RA 1994 Temperature, time, and reptile egg water exchange. Israel Journal of Zoology 40:293-306.

Ackerman RA & Dmi'el RA 1985 Energy and water vapor exchange by parchment-shelled reptile eggs. Physiological Zoology 58:129-137.

Baudinette RV 1973 Physiological correlates of burrow gas conditions in the Californian ground squirrel. Comparative Biochemistry and Physiology 48:733-743

Bels VL & Van de Sande PA 1986 Breeding the Australian carpet python *Morelia spilotes variegata*. Antwerpen Zoo International Zoo Year Book 25:231-238

Bennett NC, Jarvis JUM & Davies KC 1988 Daily and seasonal temperatures in the burrows of African rodent moles. South African Journal of Zoology 23:189-196

Bentley PJ & Blumer WFC 1962 Uptake of water by the lizard, *Moloch horridus*. Nature 194:699-700.

Bradshaw SD 1997 Homeostasis in Desert Reptiles. Springer, New York.

Cooper-Preston H 1992 Geographic variation in the population dynamics of *Crocodylus johnstoni* (Krefft) in three rivers in the Northern Territory, Australia. PhD Thesis, University of New England, Armidale.

Covacevich J & Limpus C 1972 Observations on community egg-laying by the yellow-faced whip snake, *Demansia psammophis* (Schlegel) 1837 (Squamata: Elapidae). Herpetologica 28:208-210.

Fitch HS 1954 Life history and ecology of the five-lined skink, *Eumeces fasciatus*. University of Kansas Museum of Natural History 8:1-156.

Hughes BO, Gilbert AB & Brown MF 1986 Categorisation and causes of abnormal egg shell relationships with stress. British Poultry Science 27:325-338

Mills AD, Nys Y, Gautron J & Zawadski J 1991 Whitening of brown-shelled eggs: individual variation and relationships with age, fearfulness, oviposition interval and stress. British Poultry Science 32:117-130

Pianka G, Pianka E & Thompson G 1996 Egg laying by thorny devils (*Moloch horridus*) under natural conditions in the Great Victoria Desert. Journal of the Royal Society of Western Australia 79:195-197

Quintana MG 2001 Thermal optimum for the incubation of "red teyu" eggs (*Tupinambis rufescens*: Sauria: Teiidae). Revista del Museo Argentino de Ciencias Naturales Nueva Serie 3:77-84

Roper TJ, Bennett NC, Conradt L & Molteno AJ 2001 Environmental conditions in burrows of two species of African mole-rat, *Georhychus capensis* and *Cryptomys damarensis*. Journal of Zoology 254:101-107

Rose RA & Marzec G 1990 The Reproductive Biology of Pythons and Boas. Institute for Herpetological Research, Stanford.

Seymour R, Kennett R & Christian K 1997 Osmotic balance in the eggs of the turtle *Chelodina rugosa* during developmental arrest under water. Physiological Zoology 70:301-306

Shine R 1988 Parental care in reptiles. In: Biology of the Reptilia, Vol 16 (eds C Gans & RB Huey). Allan R Liss, New York, 275-329

Shine R 1998 Australian Snakes: A Natural History. Reed Books. Sydney.

Shine R & Brown GP 2003 Effects of seasonally varying hydric conditions on hatchling phenotypes of keelback snakes (*Tropidonophismairii*, Colubridae) from the Australian wet-dry tropics. Biological Journal of the Linnean Society: in press.

Somma LA & Fawcett JD 1989 Brooding behaviour of the prairie skink and its relationship to the hydric environment of the nest. Zoological Journal of the Linnean Society 95:245-256

Sporn C 1965 Additional observations of the life history of the mountain devil, *Moloch horridus*, in captivity. West Australian Naturalist 9:157-159

Thompson SA 2003 Reproductive observations of a thorny devil, *Moloch horridus*, in a natural semi-arid environment. West Australian Naturalist: in press.

Whitaker Z & Whitaker R 1977 Notes on captive breeding in mugger (*Crocodylus palustris*). Journal of the Bombay Natural History Society 75:228-231.

Withers PC 1993 Cutaneous water acquisition by the thorny devil (*Moloch horridus*: Agamidae). Journal of Herpetology 27:265-270

York DS & Burghardt GM 1988 Brooding in the Malayan pit viper, *Calloselasma rhodostoma*: temperature, relative humidity, and defensive behavior. Herpetological Journal 6:210-214